HEC-6: Scour and Deposition in Rivers and Reservoirs

Contact Information

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Download Information

Availability: Nonproprietary
Cost: N/A

HEC-6 was developed for the U.S. Army Corps of Engineers, but the model program files, executables, and documentation are available for free download by the public at the website above. However, the Hydrologic Engineering Center (HEC) of the U.S. Army Corps of Engineers will not provide user support to non-Corps users. In addition, public distribution of the model source code is generally discouraged by HEC.

Proprietary versions of HEC-6 are also available through venders that provide model distribution and user support for a fee. A list of venders is included at the HEC website. Some proprietary versions of HEC-6 include enhanced simulation capabilities that expand on limitations of HEC-6 and provide more user friendliness. For example, the proprietary HEC-6T (MBH Software, Inc., 2002) provides additional plotting and hydraulic simulation capabilities not available in the HEC-6 version downloadable from HEC.

Model Overview/Abstract

HEC-6 is a one-dimensional open channel flow model capable of simulating changes of river profile due to scour and/or sediment deposition. Based upon flow records, a water surface profile is calculated that provides an energy slope, velocity, and depth at each cross-section. These predictions are used to estimate potential sediment transport rates at each section, which are considered with volume of flow and sediment yield from upstream sources to determine the scour and deposition. Changes in bed elevation, which impacts channel geometry and subsequent sediment transport potential, are also computed for each section. HEC-6 can be used to simulate both channel and reservoir sediment deposition and can include analysis of impacts of dredging.

Model Features

- Water surface and energy profile simulation
- Sediment scour and deposition modeling
- Sediment transport modeling
- River geometry simulation

Model Areas Supported

Watershed	None
Receiving Water	High
Ecological	None
Air	None

Groundwater	None

Model Capabilities

Conceptual basis

Capability to analyze networks of streams, reservoirs, automatic channel dredging, various levee and encroachment options, and several options for computation of sediment transport rates.

Scientific detail

HEC-6 (HEC, 1991a) simulates sediment bed and suspended load transport as a function of Einstein's Bed-Load Function (1950) that assumes an alluvial stream with consistent sediment material between the streambed and that moving in the stream. Based on characteristics of the stream hydraulics and the sediment material (e.g., grain size distribution), the rate of sediment transport is calculated.

A one-dimensional energy equation (USACE, 1959) is used to compute water surface profiles for characterization of stream hydraulics. Flow conveyance limits, levee hydraulic assumptions, and hydraulic energy and resulting water surface elevation are simulated in a manner similar to HEC-2 (HEC, 1991b). HEC-6 can be operated in a "fixed bed" mode that is similar to a HEC-2 application for simulation of water surface elevation only.

Sediment transport rates can be estimated by HEC-6 for grain sizes up to 2048 mm. Different methods for sediment transport are used by HEC-6 based on grain size and user specification. Sediment transport potential is based only on hydraulic and sediment material characteristics. Boundary conditions for sediment loading at the river main stem, tributaries, or inflow/outflow points can be specified to change with time.

Model Framework

The model can represent a river or reservoir system consisting of a main stem, tributaries, and local inflow/outflow points in a one-dimensional mode. Inflowing sediment loads are related to water discharge by sediment-discharge curves for the upstream boundaries.

Scale

Spatial Scale

- Operation unit one-dimensional

Temporal Scale

- Variable timesteps—Short timesteps must be taken during flood events when large amounts of sediment are moving and the hydrograph is rapidly changing. Longer timesteps are used during low flow periods.
- This is discussed in further detail in the document *Guidelines for the Calibration and Application of Computer Program HEC-6* available at http://www.hec.usace.army.mil/software/legacysoftware/hec6/td13-documentation.htm

Assumptions

- Bed material transport algorithms assume that equilibrium conditions are reached within each timestep.
- The cross section is subdivided into two parts representative of a movable and immovable bed based on limits of the wetted perimeter and other considerations.
- The entire wetted part of the cross section is normally moved uniformly up or down; however, an option is available to adjust the bed elevation in horizontal layers when deposition occurs.
- Irregularities of the streambed are not simulated, but Manning's n values can be specified as functions of discharge that can be assumed to indirectly account for effects of bed forms.

Model Strengths

- Simulates the sediment passing through each cross section and the volume of sediment deposited or scoured at each section.
- Can be used for simulating changing sediment and hydraulic conditions
- Can be used for simulation and design of channel or reservoir dredging

Model Limitations

- Does not include capabilities for simulating the development of meanders or lateral distribution of sediment load across a cross section.
- Does not simulate density and secondary currents.
- Designed to analyze long-term scour and/or deposition. Single flood event analyses must be performed with caution.
- Sediment transport in diverging streams is not possible
- Flow around islands (i.e., closed loops) cannot be directly accommodated
- Only one junction or local inflow point is allowed between any two cross sections.

Application History

See available references.

Model Evaluation

Results of model testing and evaluation are reported extensively by HEC (1986, 1990a, 1990b, and 1991a).

Model Inputs

- Stream cross-sectional geometry and longitudinal elevation information
- Sediment particle characteristics
- Time series data of boundary inflows and sediment loading assumptions

Users' Guide

HEC-6, Scour and Deposition in Rivers and Reservoirs, User's Manual (HEC, 1991a). Available online: http://www.hec.usace.army.mil/software/legacysoftware/hec6/hec6-documentation.htm.

Technical Hardware/Software Requirements

Computer hardware:

The minimum hardware requirements include

- 570 KB of RAM
- 20 MB of free disk space

Operating system:

PC-DOS. Two editions of the HEC-6 program are distributed in the HEC-6 package: "overlayed" and "extended memory." While the basic programs are the same, the extended memory version runs faster and provides for up to 500 cross sections in a 10-stream network, whereas the overlayed version only allows 150 sections. The overlayed version operates within the DOS 640K limit (570Kb RAM). The extended memory version requires a 386 (or better) computer with 2–4MB extended memory and a math co-processor.

Programming language:

FORTRAN

Runtime estimates:
Minutes to hours

Linkages Supported
HEC-DSS

Related Systems
HEC-6T, HEC-2

Sensitivity/Uncertainty/Calibration
HEC (1991a) provides a description of the sensitivity of simulated bed profile changes to various input data uncertainties. A qualitative assessment of the sensitivity of model results to field data (geometry, sediment and hydrology) is presented in the manual. HEC (1991a) also reports results of analyses of sensitivity to cross sections, movable bed limits, roughness, bed material gradation, inflowing load, flow record, rating curve, and temperature. Additional results of model sensitivity analyses to bed roughness is reported by HEC (1992). Apart from sensitivity, HEC (1986 and 1991a), USACE (1992), and Gee (1984) provide detailed descriptions and guidance in calibration and selection of hydraulic and sediment modeling parameters.

Model Interface Capabilities
HEC-DSS (HEC, 1990c) can be used for managing and displaying time series data when simulating for long time periods.

References
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